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BRAIN AND SKULL CORRELATIONS.

BY S. V. CLEVENGER, M.D.

THE sizes and shapes of skulls afford only unsafe anthropological and psychological generalizations. While the broad, the long, and the round heads are characteristic of certain races, they are even less invariably so than that the Mediterraneans are black-haired and the Norse are "tow-headed."

Heretofore crania have usually been studied as though it were possible to detach them from everything else in the universe. Their relationship to the contained brains, the phylogenetic and embryological development of the brain and skull together, and the influences of the one upon the other, have had but the most superficial consideration. The vast store of facts afforded us by modern biology, undigested and disjointed though they be, will yield unmistakable results if properly considered in relation to cause and effect association.

Every comparative anatomist has called attention to the occipital position of the foramen magnum of the lower vertebrates, and the tendency of this foramen to occupy a position farther forward in the ascending scale of the mammalia, until, in the primates, it is near, or at, the centre of the base of the skull.

In the *Journal of Nervous and Mental Diseases*, April, 1880, in an article entitled "Sulcus Rolando and Intelligence," I called attention to the different positions occupied by this fissure in different brains, showing that the sulcus of Rolando was placed farther backward in the adult than in the younger animal, and that it formed the posterior boundary of the frontal lobe, which, developing as the intelligence was greater, pressed backward upon the parietal and occipital brain, causing the cerebellum to be covered by the cerebrum; the lesser size of the frontal lobes allowing the brain to fall forward in its case, leaving the cerebellum of quadrupeds uncovered, and this same pressure from before backward, projecting the temporal from the occipital lobe, and the temporal, finding more room below, curled under and forward in its growth and forms the fissure of Sylvius. I also noted that this crowding backward of the frontal brain as it grew larger affected the development of the skull, and as the tendency of the animal to assume more and more the erect posture balanced the head upon the more perpendicular spinal column, that the spinal cord necessarily assumed less obliquity of junction with the brain base, until, in some men, the angle of the cerebrum and medulla oblongata is 90 degrees. At the same time, the forehead, by pressure of the brain from behind, had a tendency to become more prominent.

At a meeting of the Chicago Academy of Medicine, March 13, 1891, when a number of convict skulls were being examined, I reminded the Fellows present of the publication mentioned, and stated that if this lessened obliquity of the medulla could be accepted as an index to the greater intelligence of animals, there might also be an osseous adaptation of the occipital bone to the angle formed by the medulla and brain. I therefore arranged the skulls in a series from greater to less angularity of the basi-occipital or basilar process, and was assured by Drs. Lydston, Williams, and Talbot, who were familiar with the histories of the individuals whose skulls were thus arranged, that this estimation of their intelligence was a very good one. With a pardonable desire to fully establish my priority to this announcement, I will mention that there were present Drs. Lydston, Talbot, Moyer, Kiernan, Stillman, Lagorio, Zeisler, Pynchon, and Williams at this March 13 1891, meeting.

The exterior surface of the basilar process, unless compensated by differences in diploe thicknesses or in some other way, should give a corresponding inclination to the pharynx at the junction of the basi-occipital with the body of the sphenoid, and as many thousand observations would be needed to establish relationships of this kind, I have concluded to ask laryngologists and others who have occasion to frequently examine throats, to keep records of pharyngeal appearances and other data, from which deductions may be made, as follows: —

1. Inclination of posterior pharynx.

First degree, approaching the obliquity found among quadrupeds.

Second degree, obliquity less than first and greater than

Third degree, upright basilar process, or nearly so.

For the present, at least, more divisions between perpendicularity and the horizontal can scarcely be made in the living person, owing to muscular, mucous, and other coverings varying in thickness, enabling rough estimates only. A separate set of observations should be made upon skulls, where sufficient was known of the history to form an estimate of intelligence, the base for measurements being the same as with Camper's angles.

2 Shape of skull — brachycephalic, dolichocephalic, mesocephalic.

3. Size of skull, large, medium, or small for the age, height, or sex.

4. Intelligence.

5. Education.

6. Camper's angle.

7. Other information not included above, as to disease or injury affecting skull or brain, criminality, insanity, etc.

The correlations should be accepted as inter-dependent and not disconnected. For example, instead of intelligence being indicated by a high, wide, bold forehead, there may be hydrocephalic idiocy, and, generally speaking, we may sum up some cranio-cerebral peculiarities thus: —

1. The more erect position tends to move the foramen magnum forward. Increased intelligence and erectness are generally, but not invariably, associated in animals, so the position of the foramen alone as an index has a restricted value.

2. The frontal brain-growth is always associated with increased intelligence, and this development crowds the sulcus of Rolando farther back and pushes the medulla oblongata and pons Varolii into a more and more upright position, provided the brain-growth is greater than that of the skull, for a roomy skull may afford expansion and allow the primitive obliquity of medulla and occipital bone to persist.

3. The adjustment of the skull to its contents is a complex matter, but may be better understood by relating cause and effect as acting upon both more or less simultaneously, particularly with regard to the differences in hardness and developmental changes in both. For example, the beaver's skull and brain seem to have kept pace together so as to render convolutions unnecessary, and the beaver is an intelligent animal. The brain of Professor Leidy was highly convoluted, and appears to have been rendered so by his cerebral being greater than his skeletal growth, and this would seem to have been a family peculiarity, for his brother's brain presented a similar appearance of crowded convolutions.

4. When a juvenile retreating forehead has gradually been replaced in an adult by a more perpendicular one, through education acquired later in life, then the frontal brain may have crowded

and formed more numerous convolutions and fissures in consequence, but the pharynx may not be changed from the original inclination.

5. The softer brain is likely to undergo more rapid changes than the harder skull, either in the evolution of species or the individual, and the mere cranial conformation may or may not, therefore, be an index to brain area and intelligence, and whatever changes may occur in the skull due to brain increase have reference more to enabling the brain to find room in the cranium, so that a higher forehead may render the more erect basi-occipital unnecessary, or *vice versa*, and normal or abnormal growth of brain may raise both osseous portions.

Some mongrel dogs may inherit a larger brain from one parent and smaller brain-case from another, which would account for the deep indentations in their skulls, the pressure causing them sometimes to suffer from epilepsy and other brain derangements; this disparity is not likely to be so great in the offspring of better-mated species.

6. Many other matters could be considered, such as centres of ossification and cartilaginous persistence between such parts as the basilar process and sphenoid, enabling adjustment of the pharynx to the changed medulla angle.

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INDICATIONS OF A RAINY PERIOD IN SOUTHERN PERU.

BY A. E. DOUGLASS.[1]

IT is sufficiently easy to assert that at some remote period this country had abundance of water; but very few writers have taken the trouble to point out the actual indications to that effect.

There are two causes which operate to make this climate dry. The first is found in the south-east trade-winds being stopped by the high mountain ranges in the interior to the east of us. The second consists in the fact that the winds which do reach our sea-coast come from the colder regions to the south, and consequently will take up moisture and not deposit it. Therefore, a change from a wet to a dry climate was probably caused by a considerable increase in the average elevation of the Andes. If such was the case it must have occurred at some very remote period.

Before entering fully upon the subject, it is safe to remind one's self that a small amount of water acting through a great length of time can accomplish almost as much wearing as a great amount in a short time. Therefore, the numerous large and deep ravines in this region do not necessarily indicate a great quantity of water at some past epoch.

The purpose of this paper, then, is to point out some particulars which indicate that at some geological epoch there was abundance of water in this region. Unmistakable evidence has been found in two places: on Charchani and on the Pampa of La Joya.

A trip to the observatory meteorological station on Charchani, at an altitude of 16,650 feet, reveals many interesting facts. The green valley of Arequipa seems to be alluvial flats of river and perhaps lake deposits; the pink-colored pampa of Uchumayo is evidently the original volcanic tufa; while the dark-brown pampa, stretching out some ten miles from the mountain and containing a very thin vegetation, is an enormous "wash" from the mountain itself. In this is shown a water action on a scale surpassing anything that can be found about the city itself. If Charchani is a remnant of an ancient crater-ring, as seems not improbable, then a portion half as large as the present mountain has been washed down into the valley.

But there is a still more noticeable feature on the mountain itself. At an altitude of about 14,500 feet, on the ridge west of the great central ravine, the road passes for perhaps half a mile through an area of bowlders worn by water action into all sorts of curious and fantastic shapes. The rest of the ridge to its top is a regular glacial moraine of gravel and bowlders. On leaving this ridge and reaching the final slope to the summit, a little below snow-line, one finds every ledge of rock smoothed and polished on the surface, with long shallow scratches pointing down the mountain — proofs of glacial action. These striated ledges are especially noticeable at and just below the meteorological station. Therefore, at some period this pocket where our station is, between the main summit and the broken ridges to the east, was filled with ice to a depth of a thousand feet or more. This glacier slowly moved downward, completely filling the valley and at some point separating into two streams, one of which filled the great central ravine down to the spring, Canchero, and the other turned more to the west, going down probably to the same altitude of 13,200 feet.

Now the significance of an enormous glacier on Charchani is this: ravines and river valleys can be made by a small amount of water acting through a long period, but glaciers cannot; the water, or snow, must be all there at once. Moreover, the greater the supply of snow for a glacier the farther down the mountain it will come. Now, the temperature of this spring at noon of April 12, this year, was 45.5° F., and it will be shown later that the land had a less elevation in the rainy period than at present. The climate could not, therefore, have been colder. As this glacier came down to an altitude where the mean annual temperature was considerably above freezing, as shown by the present temperature of the spring, the snow supply must have been not merely moderate but quite abundant.

If we had rain enough at the present day to make these dry pampas the gardens they might be, this glacier would be seen on Charchani.

The evidence to be found on the Pampa of La Joya is equally conclusive but not equally striking. Not far below Vitor is a large ridge of volcanic mud to the west of the track. This ridge runs about north-east and south-west, and is bounded along its south east side by an open cliff where the bank has been caved away by a river flowing against it. Stretching away from this bank is the old river-bed, very broad and shallow. At a higher level, to the east of the track, the river-bed contracts into a narrow and deep channel. A surface river on the Pampa of La Joya would necessitate vastly more abundant rains than at the present day. There must have been a supply greatly in excess of the loss by evaporation or sinkage into the earth.

There are other facts also which bear on this question. Lake Titicaca once covered many times its present area. Innumerable shell-fish lived in its waters, whose remains are now found as fossils at Chililaya, Huancané, and other places, many feet above the present lake-level. The signs of this increased size are still so evident and the fossils are so much like the living species of shell-fish, that, geologically speaking, the rainy period which caused this increase and at a lower altitude supported a tropical vegetation was recent; historically, of course, its antiquity was immense. The palaces and houses on the island of Titicaca were built with the lake at practically its present level, and Tiahuanaco is not more than 150 feet above it. Coal deposits are found on the island of Titicaca and at Sumbay, but the tropical vegetation which formed them must be placed in a past so remote that the enlargement of Lake Titicaca and the glaciers on Charchani are but as yesterday.

In the beginning of this article I referred to the fact that an increase in the elevation of the mountains to the east of us may have caused the climate to become dry. That such an increase has occurred in recent geological times can scarcely be doubted. From above Tambo station down to the present sea-level traces of surf-action may be found. That means that the coast has been gradually rising out of the sea to the extent of 1,100 feet in recent geologic times. Whether it did it with perfect regularity, by occasional periods of rapid rising, or by sudden elevations, a thorough examination of the region would show. At Mollendo it is evident that the coast has not risen more than two or three feet in the last hundred years, if it has risen at all, and the fact that guano has been accumulating on the islands along the coast for many thousand years indicates that for a long period the coast has been practically stationary. Nevertheless, there can be no doubt that the last change in the coast-level was a rise of 1,100

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